STATUS OF RERTR ACTIVITIES IN ARGENTINA

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ABSTRACT

CNEA, the Atomic Energy Commission of Argentina, has defined development and fabrication activities related with the main fields of the RERTR program. This includes the qualification of high-density fuels for research reactors, the production of radioisotopes from LEU targets and the reduction of the HEU inventory.

This paper continues previous presentations in past RERTR meetings and summarizes the main activities performed in these fields during 2002-2003 and future works.

The main part of the CNEA U_3Si_2 Qualification Program will be completed within this year. The irradiation of the first fuel element was finished and the activities are mainly focused on its PIE works.

Regarding the UMo field, development works to provide support for fuel plate fabrication process and to improve understanding of UMo-Al interaction are on progress. Depending on the results of the fuel plate fabrication setup, the manufacturing of full size FE for UMo qualification program could take place during 2004. A program related with the UMo monolithic fuel is also in progress.

In the radioisotopes field LEU targets have replaced HEU-Al alloy targets for routine Mo-99 production since November 2002.

CNEA approach to minimize the Argentine HEU inventory is also presented.

1 Introduction

CNEA, the Atomic Energy Commission of Argentina, has defined development and fabrication activities related with the main fields of the RERTR program. This includes the qualification of high-density fuels for research reactors, the production of radioisotopes from LEU targets and the reduction of the HEU inventory.

This paper continues previous presentations in past RERTR meetings [1] and summarizes the main activities performed in these fields during 2002-2003 and future works.

2 Research Reactor Fuel activities

2.1 Qualification Programs

The Atomic Energy Commission of Argentina has defined development and fabrication programs to qualify the technology for the manufacturing of high-density

nuclear fuels for research reactors. These programs include at the present the fabrication, testing and irradiation of silicide fuel and UMo fuel.

2.1.1 Silicide Fuel

Within the framework of the silicide fuel qualification program two U_3Si_2 fuel elements called P-06 and P-07 were designed and fabricated by CNEA for their irradiation in the RA-3 reactor located at the Ezeiza Atomic Center, close to Buenos Aires city.

Currently this program is close to completion and the main activities are summarized in the following table:

Fuel Element	End of Irradiation (55 % Burnup)	EOL In-Pool Visual Inspection	Hot-cell Examination
P-06	Completed (May 2003)	Completed (June 2003)	One plate October 2003
P-07	October 2003	November 2003	2004

P-06 irradiation was completed on May 28, 2003. The fuel element stayed in the RA3 core during 452.5 days of operation. The positions occupied by P-06 during the irradiation and the corresponding power history are shown in Figures 1 and 2. Initially, because of requirements of the Argentine Nuclear Regulatory Authority, the fuel element was introduced in low power positions. Then, after the first periods of irradiation the P-06 was shifted to positions within the central region of the reactor.

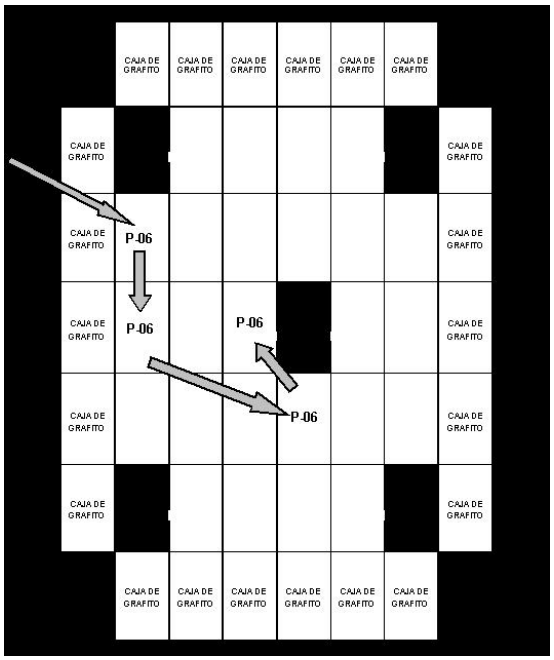


Figure 1

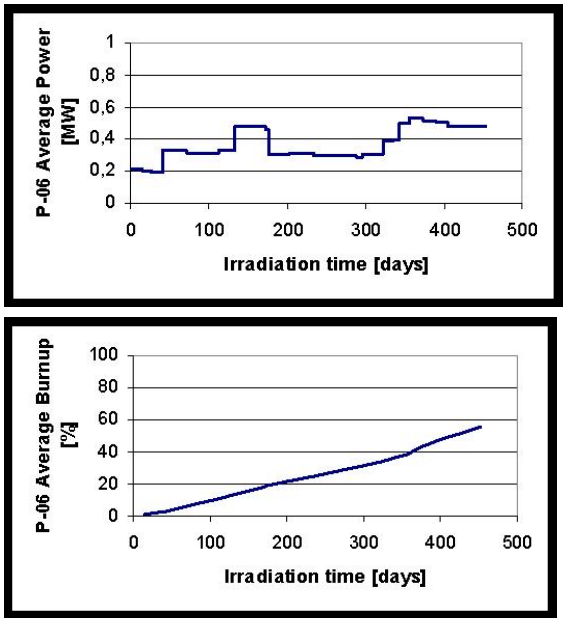


Figure 2

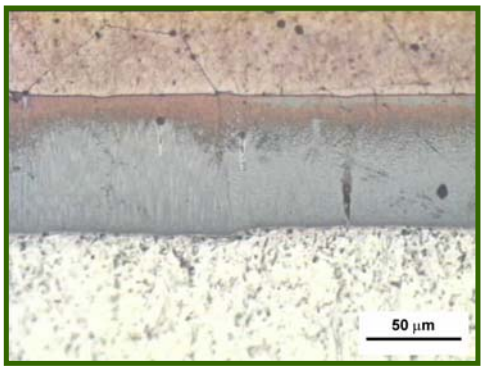
After the end of the irradiation P-06 was visually inspected at the pool side station. During the inspection no swelling, dimensional changes or blisters were

observed. The surface of the outer plates showed a uniform color of the oxide layer. A differential oxide growing between the meat zone and the frame can hardly be noticed. There are no evidences of pitting or cracking of the oxide layer. No crud deposits were observed. P06 maintains its structural integrity and no anomalies were observed. No evidence of deformations or distortions was noticed. Also there is no sing of interaction with the other fuel elements, the grid or another internals. Inspection with backlighting showed that the fuel plates remain perfectly flat without any bowing or distortion. The gap between the fuel is uniform all along the coolant channel lengths. No defects were found at the joints between the fuel plates and the structural plates. Figure 3 shows the aspect of the fuel element focusing on the upper and lower part.

Figure 3

2.1.2 UMo Program

The main activities within this program are the development of basic knowledge regarding materials interaction, the adjustment of the HMD technology for UMo powder fabrication, the development of the technology to fabricate sound plates using different UMo powders and the irradiation of full scale fuel elements in the HFR-Petten and in the RA-3. The development of basic knowledge covers studies about the diffusion between U-Mo and Al at different conditions and the characterization of the reaction layers [2]. Figures 4 and 5 show as an example the results obtained using diffusion couples when the gamma phase is stable and when it decomposes.



Figures 4 and 5

Regarding UMo powder fabrication CNEA has developed the HMD process. At the present the activities are focused on reviewing the definition of the main process parameters and powder characteristics as result of the feedback from the setup of the fuel plate manufacturing process.

Within the UMo program one of the main activities is the development of the technology to fabricate sound plates using different UMo powders. At the present the fuel plates from spherical powder could be suitable for irradiation, further developments are required for fuel plates from HMD Powder. Improving the understanding of UMo-Al interactions is an important issue in this process.

2.2 R&D

The main CNEA R&D activities in the research reactor fuel area are the works related with the monolithic fuel and the improvements in fuel modeling.

2.2.1 Monolithic Fuel

After the first results obtained by ANL from the irradiation of monolithic miniplates this alternative appears as very promising mainly for high demanding reactors. The CNEA Monolithic Fuel (MF) Program covers the development of suitable material properties and fabrication procedures, the development of the technology for high volume production, the irradiation of miniplates for fuel behavior assessment and the corresponding post-irradiation examination.

Besides using the conventional rolling process to prepare the MF CNEA is also working on the development of a new type of LEU fuel cladding from a seamless Zircaloy-4 tube gradually flattened by cold rolling. The Figure 6 shows the evolution of the transverse section of a specimen obtained from Zircaloy-4 tubing (wall thickness 0.48 mm).

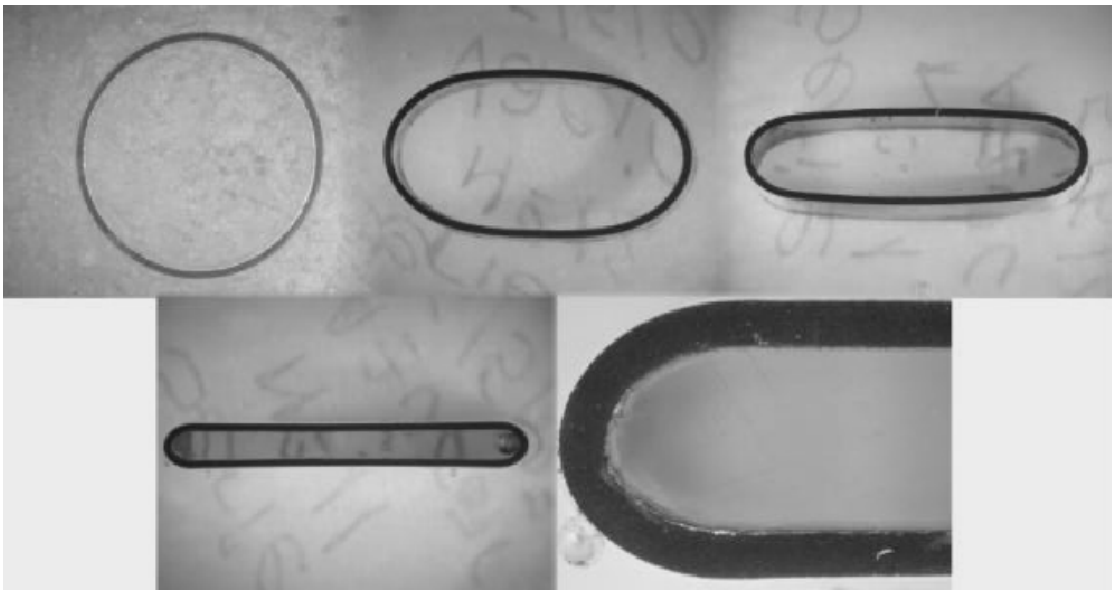


Figure 6

2.2.2 Fuel Modelling

The current activities in this field are the development of a new version of the DART code called DART THERMAL. The DART Code is a mechanistic computer model for the calculation of the performance of aluminum dispersion fuels during the nuclear service. T is code was mainly developed at ANL for the LEU Fuel Program. Its validation for LEU U-Mo dispersed fuel with PIE data mainly from RERTR 3 and

RERTR 5 sets is almost completed. CNEA and ANL are engaged in a cooperative work for the development of a new version called DART-TM which will be an extension of DART-T for a time dependent thermal and mechanical evaluation, mainly focused in the U-Mo monolithic fuel

3 Radioisotopes production from LEU

One of the main objectives of CNEA in the last years has been the replacement of HEU by LEU for the production of radioisotopes. For Mo-99 production the activities were focused on the development of both, a U-Al_x target and a U metal foil target. The first activity has been already completed and the second one is still being developed as part of an ANL-CNEA Cooperative Work since 1999.

The U-Al_x target development started in 1999 and was completed in 2000. These targets have replaced the HEU-Al alloy targets for routine Mo-99 production since November 2002. The following table shows the main characteristics of this type of targets.

Plate characteristics	Meat	Plate
Thickness [mm]	0.7	1.5
Width [mm]	30	35
Length [mm]	115	130
U-235 mass [g]	1.4	-

The Uranium metal foil target was designed in 1999 and the RA-3 irradiation rig design, fabrication and licensing was completed also during 1999. The first irradiation of ANL test targets in the RA-3 reactor was performed in December 2000. The U metal foil separation from target was good but the U metal foil alkaline digestion and Mo-99 separation was not good.

A second irradiation of ANL test targets in the RA-3 reactor took place on May 2001 with similar results. The current tasks are the design of a new dissolver and an improvement of the alkaline U metal foil digestion reaction (ANL)

4 ^{235}U Inventory reduction

In accordance with the RERTR objective, the CNEA approach in this field is to reduce practically to zero the total HEU inventory. This objective could be easily fulfilled by including the RA 6 SF in the US FRR SF AP and by reducing the HEU enrichment of the remaining material by blending down. A reduced amount of HEU should be reserved for Fission Chambers, Standards and Exempt Materials.

An important fact to be considered is that all the SF from RA 6 can be loaded in just one container. CNEA has gained, from the return of 207 RA-3 SF during year 2000, an important experience that covers all the conditioning and shipping issues. The infrastructure is still available.

Additional facts to be considered are that blending down can be performed in existing licensed facilities and that radioactive waste facilities are available for conditioning non-processable material

5 Final Remarks

The main part of the CNEA U_3Si_2 Qualification Program will be completed within this year. The irradiation of P-06 is finished and at the present the activities are mainly focused on its PIE works.

Regarding the UMo field, the HMD powder specification and the fabrication process are being adjusted to meet Fuel Plates fabrication requirements. Development works to provide support for fuel plate fabrication process and to improve

understanding of UMo-Al interaction are on progress. Depending on the results of the fuel plate fabrication setup, the manufacturing of full size FE for UMo qualification program could take place during 2004

Development of suitable materials and fabrication procedures for UMo monolithic fuel is also in progress as part of a program which first objective is to irradiate miniplates for fuel behavior assessment

In the radioisotopes field LEU targets have replaced HEU-Al alloy targets for routine Mo-99 production since November 2002.

A comprehensive approach has been defined to minimize the Argentine HEU inventory consistently with the objectives of the RERTR program. An important milestone will be the conversion of the RA-6 and the inclusion of its spent fuel in the US acceptance program.

6 References

[1] P. Adelfang et al, "RERTR Activities in Argentina", 24th International Meeting On Reduced Enrichment For Research And Test Reactors, November 3-8, 2002, Bariloche, Argentina

[2] S. Balart et al, "Reaction Layer In U- 7wt%Mo /Al Diffusion Couples", paper presented at this meeting.